NASA Science Mission Directorate
Research Opportunities in Space and Earth Sciences
NNH10ZDA001N-ROSES-2010
A.22 NPP Science Team for Climate Data Records
Abstracts of Selected Proposals

This solicitation called for investigations to continue the work of the National Polar-Orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP) Science Team, previously solicited under the 2006 NASA Research Announcement Earth System Science Research using Data and Products from Terra, Aqua, and ACRIMSAT Satellites and the 2003 NASA Research Announcement NPP Science Team for Climate Data Records.

NASA's Earth Science Program aims to utilize global measurements in order to understand the Earth system and interactions among the oceans, land, atmosphere, and biota. To achieve this goal, a combination of shorter-term, process-oriented measurements is complemented by longer-term satellite measurements of a limited number of environmental properties. For the latter, a key requirement is the provision of well-calibrated, multi-year and multi-satellite data and data product series. The NASA Earth Observing System (EOS) satellites were deployed between 1999 and 2004 to provide the new global observations needed to advance Earth system science and to initiate a number of new or improved long-term global data sets. The United States plans to continue many of these long-term data sets through the Joint Polar Satellite System (JPSS, formerly the NPOESS) beginning in 2014. The NPP mission, currently scheduled for launch in 2011, will provide a bridge to ensure data continuity between the NASA EOS research satellites and the JPSS operational environmental satellite system.

Long-term, high-accuracy, stable, environmental observations are essential to document the state of the global Earth system as well as past and future variability and changes within it. These Earth system data records (ESDRs) and climate data records (CDRs) are required for quantitative understanding of the Earth system and for ascertaining the magnitude of any natural or human-induced changes to that system. The NPP is the first satellite mission to address the challenge of providing these long-term records for a wide range of land, ocean, and atmospheric science data sets while simultaneously preparing to address operational requirements for meteorological observations. The NPP mission has two major goals:

- To provide a continuation of the EOS record of climate-quality observations (i.e., it will extend key Earth system data records and/or climate data records of equal or better quality and uncertainty in comparison to those of the EOS Terra, Aqua, and Aura sensors), and
- To provide risk reduction for JPSS instruments, algorithms, ground data processing, archive, and distribution prior to the launch of the first JPSS spacecraft.

Five sensors will be flown on the NPP mission:

- Visible Infrared Imaging Radiometer Suite (VIIRS)
- Cross-track Infrared Sounder (CrIS)
- Advanced Technology Microwave Sounder (ATMS)
- Ozone Mapping and Profiler Suite (OMPS), and
- Clouds and the Earth's Radiant Energy System (CERES)

This solicitation requested proposals from members of the scientific community to participate in the NPP Science Team. NASA requested investigations for:

- New and successor investigations to continue the evaluation of NPP/NPOESS Environmental Data Records (EDRs), to demonstrate the suitability of these data sets for use as ESDRs and/or CDRs, and to develop and evaluate improvements to EDR algorithms that could make them more suitable as ESDRs or CDRs;
- New investigations to develop scientific approaches for continuing key ESDRs begun by EOS that cannot be continued by NPP/NPOESS due either to their omission from the initial plans for NPP/NPOESS or to known performance limitations of the instruments currently in development; and
- New investigations to develop and demonstrate innovative and practical applications of NPP data.

The emphasis for all types of investigations is on securing continuous, well-characterized, long time series measurements of sufficient quality to answer critical Earth system science, global change, and/or applied sciences questions.

NASA received a total of 71 proposals in response to the solicitation and has selected 34 for funding at this time. The total funding to be provided for these investigations is approximately $18 million over three years. The investigations selected are listed below. The Principal Investigator, institution, investigation title, and proposal summary are provided. Co-investigators are not listed here.

William Balch/Bigelow Laboratory for Ocean Sciences
Generating Environmental Data Records of Ocean Particulate Inorganic Carbon with NPP/NPOESS

This proposal is to assess NPP and NPOESS (which has now become the Joint Polar Satellite System, JPSS) for derivation of particulate inorganic carbon (PIC; otherwise known as calcium carbonate, CaCO3). The goal is to verify the NPP/NPOESS PIC product as an environmental data record (EDR) and, ultimately, a climate data record (CDR). The PIC algorithm was originally omitted from the product list for NPP/NPOESS. This is despite the fact that: a) PIC represents a major part of the global carbon cycle, b) the merged two-band/three-band PIC algorithm is a standard carbon product for SeaWiFS and MODIS missions, and c)VIIRS (Visible Infra-Red Imaging Radiometer Suite) has all the bands necessary to implement the algorithm. The major challenge to the maintenance of the PIC algorithm in the NPP/NPOESS era is the availability of only a small sea-truth data set for validation purposes. The work proposed here will provide PIC algorithm maintenance (optical measurements made on two major

cruises from vastly under-sampled regions of the North and South Atlantic), specifically in support of NPP/NPOESS. We will: 1) examine the accuracy of the PIC algorithm as implemented with data from VIIRS, 2) examine ways to improve the algorithm in order to maintain the PIC environmental system data records (ESDRs) as begun by EOS, and 3) undertake collection/analysis of two other variables, chlorophyll concentration and particulate organic carbon (POC), in support of their evaluation as EDRS and CDRS. NASA will incur no ship time expenses for any of the algorithm maintenance work; both cruises are part of the Atlantic Meridional Survey, supported by the National Environmental Research Council of the U.K. These cruises represent the longest (in space and time) ocean time series on the globe, traversing between the UK and Punta Arenas, Chile. For both cruises, we will make a combination of underway ship measurements for inherent optical properties (IOPs) and apparent optical properties (AOPs), which, when combined with discrete particle analyses, will provide new validation data for an NPP/NPOESS PIC product and additional data for the validation of the chlorophyll data product. Ancillary POC measurements will also allow us to evaluate the feasibility of a new VIIRS POC product. We will do statistical analyses in order to extrapolate satellite PIC measurements from the top optical depth to the entire euphotic zone (or deeper), depths effectively invisible to the ocean color satellites but of great biogeochemical relevance, nonetheless. Equipment funds are requested for: a) a fluorometer for colored dissolved organic matter to our sampling system, so that we can better evaluate the impact of colored dissolved organic carbon on the PIC and chlorophyll algorithm performance and b) several key pieces of hardware to allow us to construct a second system for underway analysis of AOPs and IOPs (required because of tight cruise schedules in 2012).

This proposal addresses 2 of the 6 Earth science focus areas: 1) Carbon Cycle and Ecosystems plus 2) Climate Variability and Change. It supports 3 objectives identified for NASA Carbon Cycle and Ecosystems research: (1) document and understand how the global carbon cycle, terrestrial and marine ecosystems are changing, (2) quantify global productivity, biomass and carbon fluxes; and (3) provide useful projections of future changes in global carbon cycling and marine ecosystems for use in ecological forecasting, and as inputs for improved climate change predictions. This work will be critical to seamlessly transition products such as PIC, chlorophyll and POC from the SeaWiFS and MODIS missions to the NPP/NPOESS era. Ultimately, it will allow better evaluation of the future global carbon cycle as it is impacted by climate change.

Bryan Baum/Space Science and Engineering Center
Evaluation of VIIRS Cloud Top Property Climate Data Records and their Potential Improvement With CrIS

In support of NPP, the Space Science and Engineering Center (SSEC) at the University of Wisconsin-Madison hosts the Product Evaluation and Test Element (PEATE) focused on aerosol and cloud properties. The Atmosphere PEATE is responsible for providing resources to the NPP Science Team members to help evaluate the contractor (Northrop Grumman, or NG) cloud and aerosol products. Part of this evaluation lies in comparing the NG products to those obtained with heritage algorithms. The functionality of the

PEATE has been increasing steadily and to date it has provided critical resources for evaluating NG cloud products based on VIIRS proxy data.

We propose to continue our work to evaluate NPP cloud-top-property environmental data records (EDRs) and to evaluate their suitability for providing continuation with those obtained from current operational MODIS (both Collection 5 and future Collection 6) cloud products. A primary goal is to develop a comprehensive set of long-term, consistent, and validated climate data records (CDRs) that are valid across multiple missions and satellite sensors. Based on our previous analyses of the contractor algorithm theoretical basis documents (ATBDs) and the limited cloud products made available based on VIIRS proxy data, issues remain to be addressed in the cloud parameters. One reason for this expectation is that the contractor algorithms do not have heritage, i.e. they have not been used operationally for global products and lack extensive validation. Another reason is that the VIIRS imager does not have absorption channels as does MODIS; without these channels the VIIRS information content is insufficient to infer accurate cloud top heights for optically thin clouds such as cirrus. A third reason is that we need to have continuity in cloud products between morning and afternoon platforms, i.e., between MetOp-A and NPP. Our goal is to ensure that cloud-top heights, both daytime and nighttime, achieve CDR quality. To mitigate anticipated deficiencies in the VIIRS cloud heights, we further propose to integrate and validate an approach that uses CrIS hyperspectral data to supplement the information provided by VIIRS. All three named investigators (Baum, Menzel, Weisz) request membership on the Atmosphere Measurement Science Team.

Specific goals are to:

1. Continue to evaluate the contractor cloud products developed from VIIRS proxy data (prelaunch) and those from VIIRS (post-launch),
2. Implement cloud-top height/pressure retrieval software at the Atmosphere PEATE based solely on IR hyperspectral data (i.e., AIRS, IASI, and eventually CrIS),
3. Analyze the hyperspectral IR data independently from that of the imager, at least initially. The approach is to build a daily map by adopting a common grid, intercompare the gridded cloud heights, and decide on a straightforward way to use the hyperspectral IR data to improve problem areas in the imager products,
4. Continue to develop an approach in parallel that merges the imager and sounder data more directly using MODIS+AIRS (Aqua) and also AVHRR+IASI (MetOp-A). This additional complexity provides a mechanism to improve the imager pixel-level cloud top heights. This process will be extended to regional and subsequently global data,
5. Implement MODIS+AIRS and VIIRS+CrIS software for use with direct broadcast data,
6. Compare VIIRS cloud products to those from VIIRS+CrIS upon launch of NPP, and
7. Conduct studies to evaluate the cloud products from morning/afternoon imager-sounder sensor pairs and their uncertainties. Our intent is to mitigate cloud height differences caused by sensors so that we can isolate morning and afternoon cloud signatures.

William Blackwell/MIT Lincoln Laboratory
Development and Validation of Climate Data Records for the NPP Advanced Technology Microwave Sounder (ATMS)

Observations from space-based passive microwave sounders have been used for many years to derive long-term trends of the atmospheric thermodynamic state, among other important scientific purposes. Data from the Advanced Technology Microwave Sounder will continue this Climate Data Record, and it is therefore critically important that care be taken to ensure that the observed radiances are recorded and interpreted with the highest possible fidelity. We propose a multi-faceted complementary approach to optimizing and validating the ATMS radiances to facilitate their use in climate studies by leveraging recent ATMS calibration activities performed in support of the NPP/Aqua Sounder Science Team. First, key sensor calibration parameters have been measured during instrument fabrication and development but are not currently planned for use in the present operational context. These parameters include detailed radiometric passband responses, polarization knowledge, and antenna pattern measurements. We propose to improve the ATMS CDRs by incorporating these important sensor characteristics in a new advanced ATMS calibration processing system. Second, NPP spacecraft maneuvers are expected to provide ATMS field-of-view characterization that could be used to significantly improve brightness temperature scan biases without requiring empirical corrections that could potentially degrade climate signatures either by obscuring their presence or by introducing specious signals. These maneuvers would ideally occur near the beginning of mission life, but end-of-life maneuvers would also be revealing. We propose to leverage recent simulation studies to develop a framework for the analysis of observations from an NPP spacecraft maneuver. Third, we propose to conduct global intersatellite comparisons to further validate and improve the ATMS calibration accuracy. This work will be performed in collaboration with several international groups, including the GPM cross-calibration team, the NPOESS/JPSS calibration/validation team, and the Global Space-based Inter-Calibration System (GSICS).

Ivan Csiszar/NOAA/NESDIS
The Active Fire Data Record from NPP VIIRS

The goal of this proposal is to develop a prototype active fire product and a production system for the NPP Visible Infrared Imager Radiometer Suite (VIRSS) to ensure continuity with the data record from the NASA Moderate Resolution Imaging Spectroradiometer (MODIS). We will undertake the following tasks: 1. Complete and document the evaluation of the utility of the NPP VIIRS Fire ARP and determine alternative approaches and additional processing needed to use the VIIRS data to extend the MODIS Active Fire ESDR; 2. Perform an intercomparison between the MODIS, VIIRS and forthcoming ESA Sentinel 3 SLSTR (Sea and Land Surface Temperature Radiometer) fire products; 3. Develop a prototype production system for the VIIRS active fire product within the NASA LANCE-MODIS data system and establish a pathway for the transition of the processing system for an operational VIIRS active fire product to NOAA; and 4. Continue sensor evaluation and advocacy for necessary

modifications on future JPSS VIIRS sensors. The proposing team has led the development of the MODIS active fire product suite and is closely associated with the NASA MODIS Science Team. We will develop an end-to-end approach for product development, prototyping and transition, building on the success of the NASA Land PEATE, Rapid Response and LANCE-MODIS systems.

Evan Fishbein/Jet Propulsion Laboratory
Climate Data Record Assessments for the Cross-track Infrared Microwave Sounder Suite Using Simulated Data and Retrieval Algorithm Diagnostics

Our proposed activity will assess and augment the capabilities of the Cross-track Infrared Microwave Measurement Suite (CrIMSS) environmental data records (EDR) algorithms to produce climate data records (CDR) with well-quantified uncertainties and continues our contributions to the NPP science team. State-dependent error, especially from clouds, is the primary limit to effective climate research using EDRs from infrared and microwave sounders. Infrared sounders are especially prone to these errors and our research will quantify them and test mitigation strategies. We will use two assessment strategies: 1) algorithm testing with synthetic data and 2) offline error characterization using computed radiance residuals and solution averaging kernels and covariance matrices. We will assess both the EDRs and the microwave-only IPs as potential CDRs.

We have developed the CrIMSS simulations system and will use it to generate data containing climate signals. These will be processed through the EDR code and we analyze the result to infer how the climate signals are corrupted by the measurement system. We have defined specific climate signals to analyze climate signals from increasing carbon dioxide, temperature and planetary waves. However our simulations are flexible and we will collaborate with the science team to develop tests, which can identify the capabilities of these sensors to measure climate.

We have implemented an offline CrIMMS radiance forward model and we will use this to calculate solution radiance residuals, averaging kernels and solution covariance matrices. The radiance residuals will be used to diagnose state-dependent errors and their dependence on cloudiness and surface properties. Averaging kernels will be used to determine how information varies with cloudiness and the vertical extend and resolution of the profiles. The solution error covariance matrix and radiance residual vector will provide estimates of accuracy and precision. We will also use comparison with correlative data to independently validate the error estimates.

Our work specifically addresses the need of producing multi-sensor climate data sets with well-quantified errors from satellites. Our team has served on the NPP science team and is closely associated with the Sounder PEATE. We are familiar with the capabilities and limitations of the CrIMSS EDR algorithms and products, and the contractor and IPO calibration and validation activities. Our team provides unique capabilities, not provided by these other activities, which are needed to use these data in climate research.

Mark Friedl/Boston University
Towards a Land Cover Climate Data Record from VIIRS

This proposal describes research focused on method and data set development in support of a land cover climate data record from NPP VIIRS. Land cover will be generated from NPP via the VIIRS surface type environmental data record (EDR). This EDR will include global maps of land cover at 1-km spatial resolution and quarterly time steps. To generate this data, the NPP surface type EDR will use an approach that is similar to the MODIS land cover type classification algorithm, but which deviates from the MODIS approach in several key aspects. Hence, results from these two products are likely to be quite different. Further, neither the MODIS land cover product nor the VIIRS surface type EDR are designed to accurately track global land cover changes and there is no strategy for continuity of moderate resolution global land cover data sets between VIIRS and MODIS. The activities described in this proposal are designed to address these issues. Specifically we propose a framework and associated set of analyses designed to (1) distinguish stable land cover regions from regions where change may be occurring, (2) identify and label pixels that exhibit spurious change due to poor classification performance, and (3) identify pixels where real change is occurring and to categorize the nature of changes at these pixels according to a framework appropriate to moderate resolution remote sensing observations from instruments such as VIIRS and MODIS. Key elements of the proposed activities include land cover change model development at a set of well- characterized locations with known land cover properties and changes that span a range of mechanisms, rates, and intensities of change. As part of this effort we also propose to develop prototype methods for assessment and validation of regional and global land cover change data sets. The proposed activities will leverage and extend experience, data sets, and algorithms developed from a decade of algorithm development in support of the MODIS land cover product.

Watson Gregg/NASA Goddard Space Flight Center
Consistent Ocean Chlorophyll from NPP

Observing long term trends in ocean color data requires consistency among successive missions, since the lifetime of each is finite. NPP/VIIRS is the next global ocean color mission, following the highly successful SeaWiFS and MODIS-Aqua sensors. Like all preceding ocean color sensors (except perhaps MODIS-Terra, which should be discounted because of inadequate capability), VIIRS has a different design and orbit than any other global sensor. Rectifying the differences among different sensors and producing consistent ocean color observations is crucial to our understanding of global ocean biology variability and trends.

We propose to investigate the ability of an established approach to improve the consistency of VIIRS ocean color data. This approach utilizes completely processed and gridded ocean color data (Level-3 Environmental Data Records), applies in situ data for an a posteriori correction, and then applies data assimilation to correct sampling problems. As a post-processing application, the approach meets the requirements of the

proposal announcement, i.e., that it does not resort to lower level data (i.e., RDRs, SDRs or intermediate products). As such, it is responsive to the specification for Section 2.2: Development of New Approaches to Extend Critical Earth System Data Records that Cannot be Produced by NPP.

Our approach has been applied to the circa 2007 data sets of SeaWiFS and MODIS-Aqua and has dramatically increased the consistency of these sensor data sets globally and in all major oceanographic basins. In addition to improving the consistency of disparate ocean color data sets, the approach also conforms more closely to in situ data, producing a unified description of ocean biology from satellites and in situ platforms.

We will test our approach in advance of launch of NPP using circa 2009/2010 processing of SeaWiFS and MODIS-Aqua, and additionally MERIS data. Then after launch and acquisition of in situ chlorophyll data, we will apply our approach to fully processed VIIRS ocean color data. We do not intend to produce or distribute VIIRS ocean chlorophyll data sets, but rather evaluate our approach with VIIRS data.

Dorothy Hall/NASA Goddard Space Flight Center
Evaluation and Improvement of the NPP VIIRS Snow Cover/Depth and Fractional Snow Cover EDRs for creation of a CDR using MODIS and VIIRS

The National Polar-Orbiting Environmental Satellite System (NPOESS) Preparatory Project (NPP) and the Joint Polar Satellite System (JPSS) will generate snow cover Environmental Data Records (EDR) from the VIIRS instrument. The Visible/Infrared Imager and Radiometer Suite (VIIRS) snow cover EDR algorithms were developed based on the algorithms used to generate the MODIS Earth Science Data Type (ESDT) products. In this project we propose to evaluate, provide error estimates of, and improve the VIIRS snow cover EDRs so that they can be used as Earth Science Data Records (ESDR), Climate Quality Records and/or Climate Data Records (CDR). The Co-I/Science PI seeks to become a member of the NPP Science Team. As the developers of the MODIS snow cover product suite, we are uniquely qualified to undertake this work. We are also well-acquainted with the design and function of MODIS and NPP/VIIRS infrastructures.

Objectives and Justification for Work.
The primary objective of this investigation is to quantify the accuracy and errors of the VIIRS snow cover/depth EDR, and the snow cover fraction EDR relative to the heritage MODIS ESDT algorithms, and ancillary sources of snow cover data. Evaluation will emphasize comparisons with the MODIS ESDT because of the similarities of the instruments and algorithms and the plans for an ESDR and/or CDR to span both the MODIS and VIIRS eras. Drawing on our extensive MODIS experience we will emphasize evaluation of errors associated with snow/cloud discrimination, refinement of the snow detection algorithm to improve the accurate detection of snow under less-than-ideal viewing conditions, and determination of other sources of error in the snow EDRs. The VIIRS snow cover fraction EDR will be evaluated against the MODIS fractional snow cover ESDT, and an improved snow fraction algorithm, improved accuracy and resolution, for the EDR will be tested and evaluated.

Approach
The Team will work with the Land Product Evaluation and Analysis Tool Element (PEATE) to evaluate the EDRs in the pre-launch testing and development phase by comparative analysis to the MODIS snow ESDT products. We will use our considerable MODIS expertise to evaluate the NPP/NPOESS EDRs to define their accuracy and error estimates. Improvements to the EDRs will be proposed, tested and evaluated in conjunction with the Land PEATE. Validation of EDRs will be draw upon resources and expertise from the Land Validation Team.

During the operational period, validation activities will be continued and even accelerate and we will compare EDRs with independent data sources, while again drawing on Land Validation Team resources.

Expected Outcomes of the Project
The primary outcome will be extensively evaluated NPP/NPOESS snow cover EDRs with well documented accuracy and error estimates. The evaluation will determine if the EDRs are adequate for use as ESDRs or CDRs and if not, improved snow cover EDRs will be tested and evaluated.

Simon Hook/NASA/JPL
In Flight Validation of VIIRS Mid and Thermal Infrared Data and Products for Earth Science

The stated goal of NASA's Earth Science Research Program is to utilize global measurements to understand the Earth system and its interactions as steps toward the prediction of Earth system behavior. NASA has identified the provision of well-calibrated, multiyear and multi-satellite data and product series as a key requirement for meeting this goal. The main objectives of this study are to validate the mid and thermal infrared data and product series from the Visible Infrared Imager Radiometer Suite (VIIRS) on the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP) and cross validate these with similar products from MODIS and ASTER.

In order to validate these data and product series we have developed a set of automated validation sites that make all the necessary validation measurements on a near continuous basis (every 2 mins). Measurements include skin (radiometric) temperature and bulk (contact) temperature together with the standard meteorological variables: wind speed, wind direction, net radiation, air temperature and relative humidity. These same data are being used to validate the mid and thermal infrared data and products from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) and the Moderate Resolution Imaging Spectroradiometer (MODIS). The ASTER instrument is on the Terra spacecraft and MODIS instruments are on the Terra and Aqua spacecraft. VIIRS is the follow-on instrument for MODIS. This work will enable a continuous and consistent validation record from the launch of Terra in 1999 through the launch of VIIRS on NPP in 2011.

The existing data have been used to validate the accuracy of the mid and thermal infrared at-sensor radiance measured by MODIS and ASTER as well as the surface temperature and emissivity products derived from the measured radiance. Various instrument artifacts have been identified and corrected thereby ensuring the data can potentially be used as Earth System Data Records (ESDRs) defined by NASA as a unified and coherent set of observations of a given parameter of the Earth system. We will continue our validation activities and conduct additional intensive campaigns shortly after the launch of the NPP spacecraft in 2011 to ensure the VIIRS mid and thermal infrared data and products are validated and any difference between them and the MODIS data are fully understood to ensure that VIIRS data can be used in addition to and ultimately in place of MODIS data in ESDRs.

Simon Hook/NASA/JPL

Improving the VIIRS Land Surface Temperature Product for use as an Earth System Data Record

The NASA Earth Science Division has recognized Land Surface Temperature and Emissivity (LST&E) as a key Earth System Data Record (ESDR) defined by NASA as a unified and coherent set of observations of a given parameter of the Earth system. Land Surface Temperature (LST) is an important long-term climate indicator, and accurate knowledge of the Land Surface Emissivity (LSE) is critical for deriving the LST and as inputs to climate models and data assimilation systems. We will evaluate and improve the accuracy of the LST product generated from the Visible Infrared Imaging Radiometer Suite (VIIRS) on the National Polar Orbiting Environmental Sensor Suite (NPOESS) Preparatory Project (NPP) to ensure that it is suitable for use as an ESDR.

Currently a dual split-window (DSW) approach is used to generate the VIIRS LST product. This approach works well for surfaces whose emissivity can be correctly assigned based on a land classification scheme (e.g. water, vegetation) but less well for surfaces where the LSE differs from the assigned emissivity (e.g. bare surfaces). A similar split-window approach is currently used to generate one of the LST products from MODIS data and has been shown to be in error by as much as 12 K when the surface emissivity is incorrectly assigned. A 12 K error far exceeds the 1 K accuracy specification for the MODIS product and the 2.5 K accuracy specification for the VIIRS product. Moreover since the classification is fixed in the MODIS and VIIRS LST algorithms, any dynamic changes in emissivity also result in large LST errors. Dynamic changes can occur as a result of rainfall, wildfires or seasonal vegetation changes. For example, a 10 K error in the MODIS LST product was observed in the area covered by the recent Station fire in Southern California due to a change in the surface emissivity that was not captured in the MODIS land classification scheme used in the MODIS LST product.

The VIIRS product will extend the LST measurements begun by AVHRR (1978 - present) and MODIS (2000 to present) to provide a 50-year continuous data record and it is essential that this record is well characterized and accurate. This study will quantify uncertainties in the VIIRS LST product and produce a dynamic emissivity product that

can be used to improve the accuracy of the existing VIIRS LST product over semi-arid and arid regions. We will assess the accuracy of the product using cross-sensor intercomparisons combined with data from a global set of validation sites and specific case studies designed test whether the product accurately responds to dynamic Earth system changes such as wildfires.

N. Christina Hsu/NASA Goddard Space Flight Center
Assessment and Advancement of NPP/NPOESS VIIRS Aerosol EDRs and Their Suitability for Climate Data Records

The determination of the global radiation balance is one of the key components of NASA's Earth Science Research Strategy to better understand the complex nature of Earth's climate. Comprehensive regional-to-global climate models (R/GCM) are playing an ever-greater role in addressing this issue. The characteristics of aerosols, especially near their sources and sinks, are essential parameters to the R/GCMs because of their important role in modifying the radiative energy balance. Many EOS-era instruments (e.g., SeaWiFS, MODIS, MISR, etc.) were designed to provide such information with a high degree of fidelity.

With the advent of this new generation of satellite sensors in the 1990s, the creation of a well-calibrated, accurate long-term aerosol dataset from satellite measurements became possible. Such a dataset is a critical component in the quantitative evaluations of global aerosol variability that provide the scientific community and policy makers the information they need to understand the role of anthropogenic aerosols in modifying the global radiative budget. The VIIRS sensors onboard the NPP and JPSS satellites will take on a key role in continuing the high-quality aerosol time series required for climate studies that was created by these aging EOS-era sensors.

The intent of this proposal is to request funding for evaluating the performance of the VIIRS aerosol EDRs and their suitability for continuing the aerosol climate data records. We also propose to advance the VIIRS operational algorithm by extending the application of the Deep Blue algorithm from MODIS and SeaWiFS to VIIRS. The results of this proposed work will serve as the first step toward integrating VIIRS aerosol products into the long-term aerosol climate data records. Specifically, our proposed objectives are:

1) To evaluate the VIIRS aerosol EDRs and to characterize VIIRS sensor performance by conducting correlative intercomparisons of the EDRs with ground based and heritage satellite products. Infrastructure will be developed to systematically and routinely acquire all the necessary correlative measurements from sources such as Aqua MODIS and the AERONET surface observation sites and to collocate them with VIIRS EDRs. Comparisons from this collocated dataset will serve as the basis for creating an aerosol EDR error matrix that will form the foundation for studies to identify any potential sensor or algorithm issues;

2) To improve the VIIRS operational algorithm by generating VIIRS science quality products using the Deep Blue algorithm to fill in the operational data gaps over deserts, semi-deserts, and urban regions; and

3) To use the Deep Blue algorithm as a bridge between VIIRS aerosol products and those obtained from EOS-era instruments such as MODIS and SeaWiFS. Intercomparisons will be performed between aerosol products derived from VIIRS and those from MODIS and SeaWiFS using a consistent algorithm for years where their measurements overlap to better link the time series from VIIRS with the data sets from the EOS-era instruments.

Joanna Joiner/NASA Goddard Space Flight Center
Evaluation and Mitigation of Cloud Effects on OMPS Nadir Ozone Environmental and Climate Data Records

We propose to establish quantitative metrics and procedures to evaluate and mitigate cloud-related errors in the OMPS nadir total and profile ozone environmental data records (EDRs) in order to ensure continuity of the high-quality Earth Science Data Records (ESDRs) and Climate Data Records (CDRs) produced using similar satellite observations.

In this proposal, we respond to NASA's call (section 2 of the A.22 NRA) for investigations to continue the evaluation of the NPOESS ozone EDRs from the nadir instruments and to demonstrate their suitability for use as ESDRs and CDRs. Furthermore, we seek to develop and evaluate improvements to these EDRs that will make them more suitable as ESDRs or CDRs. Our strategy to accomplish this goal will be to apply the lessons learned from Aura OMI and the A-train constellation of satellites. Specifically, we will

- evaluate the current OMPS total ozone and ozone profile EDR algorithms in order to quantify the expected cloud-related errors
- develop and demonstrate an innovative approach to minimize cloud-related errors based on our experience with Aura OMI
- examine the current OMPS operations plan and make recommendations on how modifications will result in significant improvements to the EDRs and candidate ESDRs and CDRs
- evaluate the performance of OMPS with respect to cloud correction after launch
- collaborate with other NPP OMPS team members to quantify cloud-related error for other critical ESDRs and CDRs (e.g., SO2) and demonstrate the application of our cloud correction to those products.

The impact of this work will extend well beyond the total and profile ozone EDRs. The approach of correcting cloud-related errors yields a data product that is of scientific importance in and of itself: the optical centroid pressure (OCP). The OCP is a standard OMI data product. It begins a record that will be carried on with the TROPOMI instrument planned for launched in 2014 as a precursor mission for the European Space Agency (ESA) Sentinel-5 program. In addition to improving trace-gas retrievals, several

scientific applications for the OCP have been developed using OMI that may be carried on for OMPS including the evaluation of cloud vertical structure in general circulation models and the detection of multi-layer clouds.

Chris Justice/University of Maryland
Global Agricultural Monitoring: Transitioning NPP VIIRS Observations into the USDA FAS Decision Support System

The USDA Foreign Agricultural Service (FAS) is currently operates the only agricultural monitoring system that is global, providing critical information on global crop production in the context of global markets and food security. Since the 1970's, NASA and the USDA have been working together to develop the capability to monitor global agriculture with satellite remote sensing. Recently, the NASA Science Applications Program, through support of the Global Agricultural Monitoring (GLAM) project, has successfully transitioned MODIS data into the operational Decision Support Systems (DSS) of the FAS, replacing the AVHRR as the primary source of global satellite observations. The FAS system requires a well characterized, long time-series of measurements, sufficient to assess the development of crops and compare growing conditions to previous years. The NPOESS Preparatory Project (NPP) Visible Infrared Imaging Radiometer Suite (VIIRS) was planned to provide data continuity with MODIS, providing risk reduction and a bridge to the NPOESS era satellites. This NASA Applications proposal's primary objective is to continue NASA's role of transitioning NASA satellite data from research to operations by preparing NPP VIIRS data for inclusion in the operational FAS DSS. Our approach will be to replicate and improve the current MODIS FAS capabilities with the VIIRS.
The project will be carried out under the following tasks: (1) evaluation of the VIIRS instrument performance and EDR's for FAS agricultural monitoring and reproduction and enhancement of the products currently provided by MODIS to the FAS DSS for VIIRS; (2) inter-comparison of the VIIRS and MODIS data products in the post-launch period, with the aim of assessing VIIRS continuity with the MODIS data record used for agricultural monitoring, and evaluation of VIIRS data products and provisional data flows from the GSFC Land PEATE by crop analysts; (3) participation in the various functions of the NASA VIIRS Science Team and help the FAS and the GEO Agricultural Monitoring Community present their observation requirements with respect to the VIIRS instruments and data products and the future Joint Polar Satellite Systems.
The goal is to evaluate and prepare NASA VIIRS data for integration into the FAS Crop condition And Data Retrieval and Evaluation (CADRE) and Crop Explorer systems (the primary components of the FAS Global Crop Production Intelligence System) and establish compatibility with the MODIS data archive. Given that the VIIRS instrument will be launched in September 2011, this proposal will focus on evaluation of the VIIRS data and preparation for its use by FAS. Emphasis will be given to establishing data flows to enable timely delivery of VIIRS data sets in a format permitting easy ingest into CADRE and use by the FAS analysts. Responsibility for the integration and testing of these data into the operational FAS DSS is outside the scope of this research proposal.

This proposal builds on: i) the experience of the MODIS GLAM project, a collaborative research activity between the University of Maryland, NASA/GSFC, SDSU and the USDA FAS, ii) the experience gained by the P.I. on the current VIIRS Science Team and with EDR evaluation, iii) the role of the proposal team in advancing the use of NASA data by the GEO Global Agricultural Monitoring Task Ag 0703.

Bjorn Lambrigtsen/Jet Propulsion Laboratory
Assessment of ATMS Performance with Applicability to Climate Research

The Advanced Technology Microwave Sounder (ATMS) represents NASA's primary sensor investment in the NPP and JPSS/NPOESS missions. Since NASA's main interest in these missions is to enable climate research, it is important to enhance the characterization and assessment of the performance of ATMS beyond what is being planned by the Integrated Program Office (IPO) or its successor and by the NASA NPP Project office. We propose to carry out that work within the context and objectives of the NASA NPP Science Team, using tools and resources that have been developed for that purpose and which will be available through the sounder Product Evaluation and Test Element (sounder PEATE). We will address instrument performance in a climate research context, with particular emphasis on scan bias, which is expected to far exceed the magnitude of typical climate signals and must be quantified and corrected for using objective, physically based means.

Alexei Lyapustin/GEST UMBC/NASA GSFC
VIIRS Surface Reflectance and Aerosol EDR Assessment and Cal-Val Support

This is a continuation proposal which addresses the Surface Reflectance IP (intermediate product) and Aerosol Environmental Data Records (EDRs) as relevant to atmospheric correction over land for the VIIRS instrument. We propose to continue analysis of the VIIRS algorithms and codes, and take advantage of the developed AERONET-based Surface Reflectance Validation Network (ASRVN) to conduct EDR/CDR Assessment. We will also use ASRVN to develop methodology for assessment of the long-term sensor calibration stability and for vicarious cross-calibration of sensors on different orbits. These methods will be prototyped with two MODIS instruments on Terra and Aqua, and will later be applied to VIIRS data to ensure consistency between VIIRS and MODIS and between different VIIRS instruments.

Charles McClain/NASA Goddard Space Flight Center
Constructive Assessment of VIIRS Ocean Color Data Quality Towards NASA Climate Data Record Continuity

The proposed team offers to continue its support of the NPP science team up to the launch of the Visible/Infrared Imager Radiometer Suite (VIIRS) and into the postlaunch era. Our principle objectives are to determine how well EDR products from VIIRS meet heritage standards for accuracy and stability, as required for continuing NASA existing ocean color Earth science data records (ESDR) and climate data records (CDR), and

develop improvements necessary to obtain the best quality data set possible. Our strategy involves four key areas: 1) continued assessment of instrument performance and evaluation on-orbit correction methods, 2) generation of proxy data to support prelaunch and postlaunch assessments, 3) continued evaluation of operational algorithm performance, and 4) assessment of the effectiveness of calibration/validation activities. Assuming a late 2011 launch date, each of these efforts can be further divided in prelaunch preparation and postlaunch phases. The overall effort would be greatly enhanced by the proposed team's current familiarity with instrument design and performance; expertise with prelaunch characterization data; familiarity NPP/NPOESS Interface Data Processing System (IDPS) operational algorithms and NASA-selected heritage algorithms; experience and report with the current calibration and validation (Cal/Val) teams. To support advanced evaluation of products, we have already developed a VIIRS proxy data generation capability, which is designed to specifically address ocean color areas of radiometric and spectral sensitivity. All data processing capabilities required for support of assessment activities would be provided by the Ocean PEATE.

Richard McPeters/NASA Goddard Space Flight Center
Ozone Climate Data Records from the OMPS Ozone Mapper and Nadir Profiler

The proposed research is for a three-year effort to ensure that OMPS data will be suitable for long-term climate research. This proposal concentrates on the two nadir instruments, the Ozone Total Column Mapper and the Nadir Profiler, but this proposal is closely linked to a complementary proposal that concentrates on the OMPS Limb Profiler sensor. The EDR algorithms for the ozone Total Column Mapper and the Nadir Profiler will be tested using data from similar instruments currently flying. Recent work on algorithms that take advantage of the hyperspectral capability of these instruments will be evaluated for possible future use with OMPS. We will develop techniques that will allow the merger of present well established satellite ozone data sets with data from OMPS instruments on NPP and NPOESS.

Peter Minnett/University of Miami, RSMAS
VIIRS Sea Surface Temperature retrievals

Objectives: This proposal will be for the continuation and extension of current activities within the NPP Science Team which involve oversight of the aspects of VIIRS Sea Surface Temperature (SST) retrievals to attempt to ensure that the satellite series continues the time series of global SSTs derived by infrared radiometers. The experience we bring to the project is based on current and past activities with AVHRR Pathfinder, MODIS Science Team, AIRS validation Team, NPP Science Team and the GHRSST Science Team. The project would leverage activities supported through the MODIS SST algorithm maintenance activities, which are the subject of companion proposals submitted by the PIs to the ROSES09 announcement, and of the Ocean Calibration Team funded by NOAA.

Method: We will continue to evaluate results of pre-launch testing and characterization, insofar that these influence the accuracy of the SST retrievals. Anticipating the NPP launch in September 2011, we will build on the MODIS SST experience in preparing algorithm testing procedures that have to be in place at the time of launch. The early validation of the VIIRS SSTs will require rapid comparisons with other satellite SST fields (e.g. from MODIS and AMSR-E) that have already undergone extensive validation and well-defined uncertainties. In addition, ship-based radiometric measurements of the skin SST will be required very early in the mission as the VIIRS SST Key Performance Parameter includes both skin and sub-surface temperatures. We will propose to undertake the skin SST validation using the M-AERI's and ISARs radiometers currently being used for the validation of SSTs from MODIS and other spacecraft radiometers, and the new M-AERI Mk2 currently under development. We will continue to participate in Technical Interchange Meetings, periodic VOAT meetings and the NASA NPP Science Team conference calls.

Significance: SST is a Key Performance Parameter for VIIRS, and establishing the accuracies of the SST retrievals from the first VIIRS to fly is of critical importance.

Tomoaki Miura/University of Hawaii at Manoa
Evaluation and Validation of NPP VIIRS Vegetation Index EDR for Earth System and Climate Sciences

Vegetation indices (VIs) are robust and seamless satellite data products computed the same across all pixels in time and space, regardless of climatic region, biome type, and soil type, and thus represent true surface measurements. VIs are optical measures of vegetation canopy "greenness", a direct measure of photosynthetic potential resulting from the composite property of total leaf chlorophyll, leaf area, canopy cover, and structure. They have become indispensable tools in climate, hydrologic, and biogeochemical studies, land cover and land cover change detection, agricultural and ecological applications, drought monitoring, and public health. Two VIs, the "top-of-atmosphere" normalized difference vegetation index (NDVI) and the atmospherically-corrected "top-of-canopy" enhanced vegetation index (EVI), have been selected as Environmental Data Records (EDRs) to the Visible/Infrared Imager Radiometer Suite (VIIRS) sensor on the upcoming National Polar-orbiting Environmental Satellite System Preparatory Project (NPP) and Joint Polar Satellite System (JPSS) missions. The development and provision of long-term data records, however, require the effective integration of new sensor technologies and improved algorithms to better characterize global and climate change impacts on ecosystems, while preserving the fundamental attributes of the existing data record.

In this proposal, we continue the evaluation of VIIRS Vegetation Index EDRs and the development, testing, and evaluation of their algorithmic improvements to the EDRs, and quantitatively determine their quality and suitability for detecting surface-based "climate signals." We propose to use in situ observation networks for evaluating and validating long-term VI time series across multiple sensor systems [AVHRR (Advanced Very High Resolution Radiometer)-MODIS (Moderate Resolution Imaging Spectroradiometer)-

VIIRS]. These networks are evolving into highly calibrated and traceable systems and include the (1) Aerosol Robotic Network (AERONET), (2) Phenological Eyes Network (PEN), (3) Spectral Network (SpecNet), (4) Baseline Surface Radiation Network (BSRN), and (5) FLUXNET. These provide independent, in situ measurements of surface VI values, vegetation canopy states [fraction of absorbed photosynthetically active radiation; vegetation canopy processes (gross primary production, or photosynthesis, and evapotranspiration); and vegetation phenology metrics (greening, browning, flowering)]. These in situ measurements are derived at higher quality (finer spatial and/or temporal resolution) than the satellite measurement, can be applied and cross-calibrated to multiple satellites, and facilitate various methods of quality, uncertainty, and cross-sensor continuity assessments. Through these detailed evaluation work with in situ data combined with image QA analysis, we expect to determine what constitutes a "climate-quality" pixel and develop an unified "climate-quality assurance" scheme across VIIRS, MODIS, and AVHRR. We will also conduct post-launch VI product inter-comparisons across VIIRS-MODIS-AVHRR, using Diagnostic Data Records (DDRs) produced by the Land Product Evaluation and Test Element (PEATE) for regional to global scale assessments of the VIIRS VI EDR and science VI product quality and their continuity/compatibility with the MODIS and AVHRR counterparts.

Ranga Myneni/Boston University

Global LAI/FPAR Earth System Data Records from NPP-VIIRS to Extend the EOS-MODIS Time Series

One of the goals of the NPOESS Preparatory Project (NPP), scheduled for launch in late 2011, is to provide a continuation of the EOS record of climate-quality observations in the post-EOS sensor era. However, not all of the new science data products being produced by EOS were included in the NPP and NPOESS programs when they were first planned, as the NRA acknowledges. The successful EOS experience and broad community use of these products, especially LAI and FPAR, suggests inclusion of these products in the NPP and NPOESS programs - the NRA recognizes this explicitly "New investigations to develop scientific approaches for continuing key ESDRs begun by EOS that cannot be continued by NPP/NPOESS due either to their omission from the initial plans for NPP/NPOESS or to known performance limitations of the instruments currently in development." The NRA further states that "Measurement of vegetation reflectance properties allows estimation of ... leaf area index (LAI), fraction of absorbed photosynthetically active radiation (FPAR)" that is, the absence of the LAI/FPAR product in the list EDR is not due to known performance limitations of the instruments.

The justification for continuing the EOS MODIS LAI/FPAR data series with NPP-VIIRS and NPOESS measurements may be succinctly summarized as follows: (1) these products have a large user base, (2) the algorithm is mature and proven to generate accurate products, (3) the products can be generated with minimal investment from VIIRS data, and (4) the resulting continuous, well-characterized, long time series will facilitate answering critical Earth system science, global change, and/or applied sciences questions, thus meeting the primary goal of the NPP/NPOESS missions.

In light of above, the primary objective of this proposal is to extend the MODIS LAI and FPAR product series through the term of the NPP-VIIRS mission. This objective is realized through three sets of research activities -

(A) VIIRS LAI/FPAR algorithm development, prototyping and implementation
Task 1: Ensuring Continuity Between MODIS and VIIRS
Task 2: Refinement of Algorithm Theoretical Formulation for Continuity
Task 3: Adjustment for VIIRS Spatial and Spectral Features
Task 4: Algorithm Coding, PEATE Integration and Prototyping

(B) Evaluation of VIIRS LAI/FPAR ESDRs for accuracy, precision, uncertainty, spatial coverage and continuity
Task 5: Spatial Coverage
Task 6: Continuity and Consistency
Task 7: Precision
Task 8: Accuracy and Uncertainty

(C) VIIRS project activities.
Task 9: Quality Assessment and Project Activities
Task 10: Community-Support and Outreach Activities
Task 11: ATBD and User Guide

The tangible end product of this proposal will be a continuous, well-characterized, long time series of global LAI and FPAR products, spanning the EOS and NPP era, suitable for research in Earth system science, global change and applied sciences.

Ramakrishna Nemani/NASA Ames Research Center
Extending the Terrestrial Observation and Prediction System (TOPS) to NPP Applications

Over the past decade, NASA missions such as TERRA, AQUA and AURA, which were primarily launched to produce research measurements, have demonstrated their value for use in support of operational users and decision making. Data and products from instruments such as MODIS, TRMM and OMI now have significant and growing communities around the world that use these products in fighting wildfires, predicting floods and landslides, and monitoring air pollution.
Leveraging the routine observations of ecosystem conditions, we developed the Terrestrial Observation and Prediction System (TOPS) to produce operational ecological nowcasts and forecasts in support of natural resource management. TOPS is a data-modeling system designed to integrate satellite and surface observations with ecosystem models to produce operational nowcasts and forecasts of ecosystem states and function. The TOPS framework is currently being used to produce data and information products for integration with operational decision support system through multiple projects funded under the Applied Sciences Program (ASP). These ASP projects include efforts focused on crop yield monitoring, protected area management, fisheries management, public

health, and water resources management. TOPS is also a core component of the NASA Earth Exchange (NEX), a new collaboration platform for the Earth science research and applications communities that provides a mechanism for scientific collaboration and knowledge sharing. Our experiences with the ASP projects, not all equally successful, taught us many valuable lessons which are consistent with the consensus that emerged from a workshop held by ASP in February 2010. In this proposal, we address the recommendations of the workshop by leveraging existing activities such as TOPS and NEX in support of NPP applications through the following steps:

1) Understand the errors and uncertainties associated with the transition from MODIS to VIIRS with reference to Applied Sciences Program (Data Continuity)
2) Integrate NPP data and products into existing applications by conveying the errors and uncertainties (Data Continuity)
3) Continue to engage federal, state and local partners in the NPP mission by providing a platform for creating high-level products and rapid prototyping of applications (Early Integration of Applied Science Community)

Thomas Painter/University of California, Los Angeles
Next Generation Climate Data Records of Global Snow Cover from NPP VIIRS

The characterization of snow cover and its extent is critical for understanding the Earth system because the Earth's climate sensitivity is largely determined by the response of the cryosphere to climate forcings. However, our understanding of the strength of the snow albedo feedback varies by a factor of three in the GCMs, due primarily to large uncertainties in snow cover extent and the albedo of snow-covered areas from imprecise remote sensing retrievals. Snow cover and its melt also dominate regional hydrology in many of the world's mountainous areas. One-sixth of Earth's population depends on snow- or glacier-melt for water resources and coincidentally generate one-fourth of the global domestic product.
The existing snow cover products from Terra MODIS and Aqua MODIS have seen growing use in climate studies, hydrologic modeling, and glaciological applications. However, emerging from these studies has been a clear indication that the MOD10A1/MYD10A1 binary and fractional products are imprecise and lose detection capacity outside of the NPOESS Preparatory Project (NPP) specification during periods of transition in snow-covered area. It is specifically these periods that are most critical in understanding the processes and forcings of the snow-albedo feedback and most critical to the assimilation of snow cover data into hydrologic models. Despite these issues, these products are the proposed algorithms for NPP/NPOESS.
In this proposal, we show that the current algorithms for the NPP Snow Cover EDR are not capable of meeting the threshold specification for fractional snow cover accuracy, particularly during the critical periods of transitional snow cover. We then present the VIIRS Snow Covered Area and Grain size (VSCAG) modeling suite, which we demonstrate is capable of meeting the EDR specification and, by extension, that of Earth science data records (ESDRs) and climate data records (CDRs) that bridge from EOS to NPOESS via NPP. VSCAG is an implementation of the operational spectral mixture model MODIS Snow Covered Area and Grain size (MODSCAG) model with primary

products of viewable fractional snow cover and canopy-adjusted fractional snow cover. Their sister algorithm, GOESRSCAG, has been selected to map snow cover with the GOES-R Advanced Baseline Imager (ABI).
The detection capacity of MOD10A1/MYD10A1 snow cover products deteriorates to less than 70% from April through November and less than 50% from May through October. By contrast, MODSCAG's capacity remains well above 90% for all but one month of the year. The MOD10A1/MYD10A1 binary and fractional products have uncertainties in fractional snow cover of greater than 35% and 25%, respectively, whereas MODSCAG has a snow fraction uncertainty of ~8%. Therefore, these and others' data strongly suggest (1) The NDSI-based binary and fractional products under consideration for NPP and NPOESS VIIRS do not meet the Snow Cover EDR requirement of < 10% uncertainty per pixel, and (2) VSCAG/MODSCAG meets the Snow Cover EDR requirement of < 10% uncertainty per pixel and is therefore better suited for development of ESDRs and CDRs.
Key to this project is the consistency of high-quality fractional snow cover retrievals from MODIS through NPP to NPOESS. VSCAG and MODSCAG retrievals will be compared directly during the period of overlap. Before and after the overlap, we will perform regular respective validation with high-resolution snow cover retrievals from Landsat 5 TM, ETM+, ASTER, and the LDCM (2011+ tentative). During these three periods, we can establish the consistency and sensitivities of the resultant EDRs, ESDRs, and CDRs. It is expected that VSCAG will maintain the detection and quantification capabilities of MODSCAG because of the use of the full VIIRS spectrum and that the resultant products will better serve the weather, hydrology, and climate communities.

Steven Platnick/NASA GSFC
Evaluation of VIIRS Cloud EDRs and Extending MODIS Cloud Data Records into the NPP Timeframe

We propose to port and/or modify a suite of existing MODIS production cloud algorithms for use with the VIIRS instrument. Enabling these algorithms to run on the VIIRS spectral channel set will allow for direct and meaningful comparisons with the VIIRS contractor (NGST) cloud EDRs. Leveraging off this approach to EDR evaluation, and with supplemental observations from CrIS, we will also provide two options for extending MODIS-heritage cloud data records into the NPP timeframe.

Differences between MODIS cloud products and VIIRS EDRs found in future comparisons will be related to some combination of two main factors: (1) differences between the MODIS and VIIRS instruments, and (2) differences in the algorithms. De-convolving these two factors will be challenging.

The porting/modification of MODIS Collection 6 cloud algorithms will eliminate instrument-related differences and therefore provide a reference algorithm that can be used to achieve the following two main goals:

(1) Evaluation of NPP VIIRS Cloud EDRs

We will directly compare retrievals from the ported algorithms to the NPP products. Using a MODIS-like reference algorithm provides a straightforward means for assessing the NPP cloud algorithms. Because of missing spectral channels, most of the MODIS cloud algorithms will need to be modified to some extent; this is especially true of the cloud-top properties algorithm. In the absence of CO2 slicing channels, retrieval methodologies being developed for the ABI imager on GOES-R that has a similar channel set to VIIRS will be included, in addition to approaches developed for the PATMOS-x (AVHRR) cloud record. This effort is responsive to section 2.1 of the solicitation.

(2) Enabling Continuity of MODIS-like Cloud Data Records

The ported algorithms will be designed to run on both VIIRS and MODIS measurements. Therefore, as a complement to the proposed evaluation approach, our effort will also provide a means for producing an algorithm-consistent cloud data record across the MODIS- NPP timeframe (albeit, inferior to MODIS). An alternate approach that will be explored is the use of CrIS observations to provide MODIS-like CO2 bands for use in a full MODIS algorithm. This aspect of our effort is responsive to section 2.2 of the solicitation.

Lorraine Remer/NASA Goddard Space Flight Center
Aerosol Climate Data Records from Combination of MODIS and VIIRS Aerosol Products

For 10 years NASA's spaceborne EOS sensors have been observing the Earth system, providing the basis for hundreds of products including the MODIS aerosol products that have seen wide use within the community. As we transition out of the EOS era and into successor programs such as NPP/NPOESS, we require continuity. Without sufficient continuity, production of a trustworthy aerosol climate data record will be impossible. In fact, simple questions such as "is aerosol loading increasing or decreasing during the satellite era?" require that uncertainties are well characterized, and that a clear path to product continuity is determined.

There are many obstacles to creating a merged aerosol climate data record from MODIS and its continuation sensor NPP-VIIRS. Some of these include:

- sensor differences
- algorithmic differences
- sampling differences
- calibration/characterization differences

We propose to explore these factors contributing to possible discontinuities in the joined aerosol time series from MODIS and NPP-VIIRS. Our approach includes both pre-launch and post-launch components.

Before launch we will continue the work begun by Co-I Laszlo and apply preliminary versions of the VIIRS aerosol algorithms to different sets of MODIS reflectances, and then compare results of the VIIRS retrieval with those produced by the standard MODIS processing. This will be done in steps in order to isolate algorithmic differences, the effects of cloud masking and pixel selection, and the effects of the different VIIRS spatial resolution. The result of these tests will be a quantitative estimate of the uncertainties associated with matching VIIRS aerosol product with MODIS' that will serve as hypotheses for the next stage of the proposed work.

After launch we will collocate actual VIIRS aerosol products with actual MODIS aerosol products from both Aqua and Terra, and use this collocation data set to test the hypotheses formed before launch. At this time we can also explore the effect of sensor differences and look for offsets in calibration by comparing collocated reflectances, comparisons of retrieved products with AERONET, and pay particular attention to aerosol size parameter as a highly sensitive indicator of calibration issues.

The overall objective of the work proposed here is to study the aerosol products of the two sensors, and to quantify the uncertainties involved in joining the two time series together.

Henry Revercomb/University of Wisconsin-Madison
Assessment and Optimization of IR Radiance Measurements and Products for Climate, Assimilation, and Remote Sensing Applications: Continued NPP Science Team participation

This is a proposal to continue our participation on the NPP Science Team, applying over thirty years of experience with high resolution IR spectrometers to further our long-term commitment to improving the accuracy of IR observations for Earth Systems Science Research. The primary objective of the proposed effort is to assess and optimize the long-term accuracy and consistency of NPP IR radiance measurements from CrIS and VIIRS that form the basis for key climate, operational forecasting, and remote sensing applications from the new Joint Polar Satellite System (JPSS). This will be a comprehensive effort that makes use of the full complement of spaceborne high spectral resolution IR standards, including AIRS and IASI, as well as CrIS. Expectations (based on previous calibration/validation activities, including aircraft flight data, and CrIS thermal vacuum data) are that the accuracy of these systems will be generally comparable, but that identifying and quantifying the subtle differences will be very important, especially for climate applications. The radiances themselves are considered to be a key Earth System Data Record (ESDR) and specific combinations will become Climate Data Records (CDRs). Other products from CrIS will also be evaluated.

The foundation for the proposed effort is the fundamentally high calibration accuracy achievable from high spectral resolution infrared measurements (Haskins and Goody, 1998), especially those employing frequent blackbody reference views. In addition to the

space borne instruments (AIRS, IASI, and CrIS), we will make use of data from the University of Wisconsin Scanning High-resolution Interferometer Sounder (S-HIS) aircraft instrument (validated with laboratory comparisons incorporating NIST standards), and imagery from high spatial resolution airborne sensors. The broad spectral coverage of these spectrometers is also important for providing an effective transfer standard to VIIRS and other lower resolution instruments. Both the S-HIS and IASI have continuous spectral coverage from about 3 to greater than 15 microns. The CrIS and VIIRS sensors on the NPP platform will be compared for all sky global scenes. The connection between instruments on platforms in different orbits (e.g. NPP, Aqua, and Metop) are accomplished by using overlapping orbits at high latitudes, by comparing with GOES radiance measurements near the equator, and by using aircraft instrument spectra as a link. Direct aircraft radiance comparisons over the life of the JPSS mission are still the best way to re-establish connection with NIST standards post launch. In this way the NPP satellite will bridge the radiance data record between EOS and the operational JPSS missions.

The previous accomplishments of this team prove the feasibility and high value of this effort.

Crystal Schaaf/Boston University
Albedo and Bidirectional Reflectance Climate Data Records from NPP/VIIRS

"Surface albedo (and reflectance anisotropy) has been recognized by GTOS as an essential climate variable (ECV) crucial for accurate modeling and monitoring of the Earth's radiative and biophysical regimes (Schaaf et al., 2009). As such, albedo is one of the primary VIIRS Environmental Data Records required by the NPOESS Preparatory Project (NPP). Unfortunately the VIIRS specification only calls for a single broadband value, retrieved on a daily basis under cloud-free conditions at the time of overpass, whereas most numerical prediction models (and global climate and biogeochemical models) nowadays call for a representation of the surface radiation in terms of both the photosynthetically active radiation (shortwave radiation less than 0.7μm) and the near and midwave radiation (0.7- 4.0 μm). Many applications are relying on even more than two multispectral bands.

Two VIIRS algorithms have been implemented to fulfill this operational requirement for a single broadband albedo. The first (roughly based on a MODIS heritage) relies on periodic multi-day retrievals of narrowband anisotropy models to estimate the Bidirectional Reflectance Distribution Function (BRDF) of each pixel (Schaaf et al., 2002; Lucht et al., 2000) and then couples these with the surface reflectance retrieved on any single day to obtain an estimate of the daily shortwave albedo at the overpass time. The second approach relies on single-day top-of-atmosphere radiances and precomputed radiative transfer model information to estimate daily broadband surface albedos (Liang et al., 2003; 2005), particularly over highly reflective surfaces. While both approaches can provide spectral albedos, these are not currently planned for archive and dissemination. Furthermore, in the case of the MODIS heritage algorithm, the

operational user will have no access to the underlying spectral anisotropy models (the BRDF Intermediate Process or IP) for each location and therefore they are precluded from computing spectral albedos for themselves as well as computing albedo under other illumination conditions, specifying the surface boundary conditions, or correcting surface reflectances to a common view-angle. Note that reflectances corrected to a common nadir view, Nadir BRDF-Adjusted Reflectances (NBAR) are the primary input for the MODIS land cover and phenology products and a number of receiving facilities have implemented the daily MODIS Direct Broadcast BRDF anisotropy model retrieval code so that they can generate not only daily albedo, but also daily view-angle-corrected reflectances and view-angle-corrected vegetation indices to monitor local landcover change, assess rangeland capacity and estimate agricultural productivity.

Therefore this proposal seeks continued participation in the NPP Science Team and focuses on further evaluation of the contractor implemented daily albedo quantities and preservation of the long term record of climate-quality albedo, BRDFs, and NBAR quantities that has been so successfully initiated under MODIS.

David Siegel/University of California, Santa Barbara
Evaluating NPP Ocean Color Data Products in a Complex Coastal Environment: The Plumes and Blooms Program.

We propose to continue the Plumes and Blooms (PnB) satellite ocean color observational and analysis program and to use theses observations to understand the quality of NPP data products in the complex coastal environments. The scientific aim of the PnB program is the understanding of the dynamics of sediment plumes and phytoplankton blooms in a complex coastal ocean using satellite, ship & bio-optical glider observations. This aim is well suited for evaluating and creating new NPP ocean color data products. We propose to:
-Continue the monthly field sampling program of optical, biological, biogeochemical & hydrographic parameters in the Santa Barbara Channel
-Use PnB data to evaluate NPP ocean color data products and algorithms
-Supplement the PnB observational program with bimonthly, month-long oceanographic glider deployments of physical and bio-optical parameters
-Understand how phytoplankton functional type (PFT) regulates ocean color and inherent optical property (IOP) variability
-Investigate the relationships among the particle size distribution (PSD) and IOPs and develop methods for the robust assessment of PSD using NPP-VIIRS ocean color imagery
-Use the coupled PnB ship, glider and satellite observations to investigate the dynamics of phytoplankton blooms and sediment plumes in a complex coastal ocean.
Ship time for the PnB field program will continue to be provided in collaboration with the NOAA Channel Islands National Marine Sanctuary. On each PnB cruise, 7 stations are sampled providing a complete bio-optical data set for use in ocean color modeling, satellite data product assessment and interdisciplinary oceanographic science. PnB field observations include water-leaving reflectance spectra, in situ profiles of absorption,

beam attenuation and backscattering spectra as well as in situ PSD profiles using a laser diffraction particle sizer. Water samples are analyzed to determine component absorption spectra and phytoplankton pigment, inorganic nutrient and particulate organic carbon concentrations and, through partnerships with individual researchers, dissolved organic carbon, dissolved inorganic carbon (DIC, T-Alk and pH), and biogenic and lithogenic silica concentrations. Data are available via the SeaBASS database and the web (www.icess.ucsb.edu/PnB/PnB).

We propose to supplement the ship sampling to include bimonthly oceanographic glider observations which was recently purchased by the S.B. Coastal Long-Term Ecological Research site (SBC LTER). Funds are requested to conduct up to six month-long glider missions each year in collaboration with SBC LTER. The glider will greatly improve spatial-temporal sampling of the Santa Barbara Channel and will quantify uncertainties due to under-sampling of extreme conditions expected when using satellite observations alone.

The PnB data set is excellent for developing, implementing and validating satellite ocean color algorithms because of the breadth of measurements made, the inherent variability of bio-optical conditions sampled and the large number of stations sampled each year. PnB is particularly well suited for characterizing PFT amplitudes statistically, thereby creating the opportunity for quantifying the role(s) that PFTs play in IOP variability and their role in ocean color data products. Similarly, the PnB data set is well poised for investigating the relationships among the PSD and IOPs enabling new algorithms for the remote assessment of the PSD for NPP-VIIRS to be developed. This project will enable the synthesis of the dynamics of complex coastal processes using satellite, ship and glider observations while still providing an excellent vehicle for validating and creating new NPP-VIIRS satellite ocean color data products.

This proposal responds to sections 2.1(evaluate ocean color EDRs), 2.2 (cal/val) and 2.3 (develop innovative applications)in the NPP Science Team for Climate Data Records 2010 ROSES call & contributes to the NPP Science Team.

Thomas Stone/US Geological Survey
Lunar Calibration for the Next Generation of Earth-Observing Satellite Sensors

Detecting global environmental change from space requires Earth observation datasets that are stable, consistent, and continuous. Achieving the level of data quality needed for accurate assessment of climate variability requires rigorous sensor calibration in orbit; two essential components are long-term stability and inter-calibration among instruments. This proposal addresses NASA and NPP objectives for climate-quality calibration by continuing the lunar calibration project at USGS (aka ROLO), which provides the Moon as a radiometric reference source for reflected-solar wavelength instruments. ROLO is a unique project, currently funded under ROSES-2006 Appendix A.15; its products are actively utilized by NASA EOS instruments (e.g. MODIS, SeaWiFS, ALI, Hyperion) and many others, and planned for use by NPP-VIIRS. The proposed activity will contribute to NPP on-orbit calibration efforts, specifically with regard to observations of the Moon acquired by VIIRS. These and other satellite missions, including current and upcoming operational programs (e.g. LDCM, GOES-R, Meteosat) are anticipating the continued availability of lunar calibration support, to be provided through this proposal. The

methodology of lunar calibration involves accessing numerical analytic models that quantitatively predict the brightness of the Moon as seen by spacecraft instruments in Earth orbit. This activity will refine and advance the development of lunar models and the associated calibration/validation techniques. The quality assurance aspects of lunar calibration include a demonstrated capability for stabilizing radiometric calibration in orbit with high precision, and providing a common reference (the Moon) for inter-calibration of sensors; both techniques are essential to the climate assessment/variability measurement tasks of NPP, and for the construction of Climate Data Records. Additionally, the Moon limb provides a high-contrast edge that can be used to evaluate instrument imaging quality. These capabilities extend to any solar-band radiometer instruments that view the Moon, thus including those that may be called upon to mitigate gaps in U.S. observational capabilities. The calibration/QA considerations of lunar calibration can potentially impact all data products derived from VIIRS observations, including cloud optical properties, aerosols, ocean color, vegetation, and Earth albedo/shortwave radiation balance.

Lawrence Strow/University of Maryland Baltimore County
Validation of the CrIS Sensor Products for Climate Research

The CrIS sensor on NPP continues the infrared hyperspectral radiance record begun by the AIRS sensor on the EOS-AQUA sensor platform. Infrared radiances contain a host of information about the earth's atmosphere, including: temperature and water vapor profiles, cloud characteristics, a number of minor gases including CO2, CH4, N2O, CO, HDO, and NH3, and dust aerosols. One of the defining characteristics of AIRS is its tremendous radiometric stability, now estimated to be on the order of 0.002K/year or better, now over almost eight years of operation. We propose to calibrate and validate the CrIS sensor records (SDR and EDRs) in order to extend this time series into the NPP+ time frame. We will provide and end-to-end analysis of the CrIS EDR production accuracies by systematically validating the CrIS SDR, intermediate Cloud-cleared radiance product, and final EDR results, in that order. This end-to-end view is vital in order to reach CDR accuracies in the EDR products. In addition to validation, we also propose to provide in-flight frequency calibration of the CrIS sensor. Longer term attention will be paid to evaluating potential offsets between the CrIS EDR record and the AIRS Level 2 record in preparation for created an atmospheric profile CDR. The procedures used for this validation have been used extensively on AIRS and on comparisons of AIRS to the IASI sensor flying on METOP in the 9:30 orbit.

Mark Tschudi/University of Colorado
NPP Science Team Participation in Support of Cryosphere Products

The work that this proposal's team would undertake has three main goals:

- Assessment of planned VIIRS products for their utility as science-grade climate data records.
- Development and testing of product improvements, particularly targeting the VIIRS ice characterization EDR.

- Continuation of ongoing work contributing to helping to assure that the NPP VIIRS systems, processing, and calibration/validation plans best meet science user needs.

Overall, the proposed effort would continue the end-to-end assessments of the specific NPP sea-ice products noted earlier, but would also take a more integrated approach that involves making use of EOS (MODIS and AMSR-E) and POESS (AVHRR and SSM/I) data to supplement existing time series, to help reduce shortcomings in the NPP products, and to address NPOESS programmatic changes. Our proposal therefore relates to the "Integrated Data Analysis and Algorithms for Earth System Data Records" component of the ROSES announcement of opportunity.

Specific objectives to meet the above goals include:

- Continued assessment of planned NPP VIIRS sea ice products for use as CDRs, including optimal ways of merging them with existing records,
- Assessment of and contribution to NPP calibration/validation plans, including identifying gaps that are relevant for NASA science applications,
- Further review as needed of the NPP systems, software, implementation, and data archival procedures relevant to the sea ice products.
- Evaluating the usefulness of new approaches already developed by the University of Colorado (CU) and University of Wisconsin, Madison (UWM) teams to help address the shortcomings of the ice characterization EDR. These approaches have not been applied to VIIRS but have heritage using EOS and POESS data.
- Facilitating the use of NASA and international assets, including IceBridge data and products from the Cryosat-2 cal/val program now underway (of which J. Maslanik is a team member).

Menghua Wang/NOAA/NESDIS/ORA

Evaluation and Improvement of the NPP/NPOESS VIIRS Ocean Color EDRs

This proposal is for a NOAA team to support and participate in the NASA NPP ocean color science team activities, leveraging some funded calibration and validation work from the VIIRS ocean color Cal/Val program. The principal investigator (PI) will continue to serve as a science team member for the NASA NPP/NPOESS VIIRS. In addition, continued efforts on evaluation, assessment, and identification of needed improvements of the atmospheric correction algorithm for the NPP VIIRS ocean color EDRs, i.e., the normalized water-leaving radiance spectra data (nLw), are proposed. The objectives are to refine the current atmospheric correction algorithm (with the near-infrared (NIR) method) for a better performance in the open oceans and to improve the VIIRS ocean color data quality for the coastal regions using the shortwave infrared (SWIR) atmospheric correction method. It has been shown that the SWIR-based algorithms can derive significantly improved MODIS-Aqua ocean color products in the coastal turbid waters. Thus, the NIR-SWIR based VIIRS ocean color data processing can be used to evaluate and assess the performance of the VIIRS standard algorithm (from Northrop Grumman) for various open oceans and coastal regions. Furthermore, the diffuse attenuation coefficient at the wavelength of 490 nm (Kd(490)), which is an

important water property related to light penetration and availability in aquatic systems, will be generated for NPP VIIRS. Particularly, the proposed new Kd(490) data for NPP VIIRS are valid for both open oceans and coastal turbid waters, providing the continuation of Kd(490) data records from the NASA heritage ocean color sensors.

Jun Wang/University of Nebraska - Lincoln
Evaluate and Enhance the VIIRS Aerosol EDRs for Air Quality and Public Health Applications

Among all the VIIRS EDRs, most relevant to the air quality and public health applications are the Aerosol Optical Thickness (AOT) and Atmospheric Suspended Matter (ASM) EDRs. The accuracy in deriving surface Particulate Matter (PM) concentration and particle size parameter is intrinsically amenable to the accuracy of satellite AOT retrievals. To enrich NPP's applied science aspect of VIIRS aerosol EDRs, we collaborate with scientists from Centers for Disease Control and Prevention, EPA, and multi-institutional project Infusing Satellite Data into Environmental Applications (IDEA) to conduct the following tasks: (a) assess and improve the surface reflectance characterization scheme used in the VIIRS algorithm for AOT retrievals; (b) evaluate and enhance the VIIRS AOT retrieval in dusty conditions; (c) use a novel (and published) approach to conduct the independent retrieval of AOT and surface PM for evaluating and improving the VIIRS ASM EDR; and (d) infuse the VIIRS AOT, our independent estimate of surface PM, and the VIIRS ASM EDR with the IDEA and National Environmental Public Health Tracking Network (NEPHTN) for air quality and public health applications. The information content that VIIRS brings to IDEA will be further used for the diary of air quality on the U.S. air quality weblog.

Because the air quality and public health applications most often are targeted at regional scale in nature, all our proposed tasks will focus on problems and improvements of VIIRS aerosol EDRs in specific regions (such as over the semi-arid western U.S) and/or atmospheric conditions (such as during dust event). Our approach for conducting these tasks is based upon our published studies that improved MODIS c005 aerosol product in dusty atmosphere and/or semi-arid region. The approach will integrate the VIIRS clear-sky reflectance data with a chemistry transport model (GEOS-chem) to conduct the independent and self-consistent retrieval of AOT and surface PM concentration. Given that the VIIRS aerosol algorithm has a strong heritage from MODIS, and currently MODIS algorithm doesn't retrieve the ASM amount at the surface, we believe that together with the ground-based aerosol data, our proposed tasks (under the framework of an independent research-oriented retrieval algorithm focusing at regional scale and case studies) will provide an in-depth evaluation of and constructive improvement to the VIIRS AOT and ASM EDRs. We will share our progresses with the VIIRS operational algorithm team, and work together with them to enhance the accuracy of aerosol EDRs and to demonstrate the potential of these EDRs for air quality monitoring and public health surveillance.

This proposed project is based upon the PI and Co-Is' 30+ years' research experience in the forefront of remote sensing of aerosols and air quality. The investigators'

interdisciplinary collaborations with partners from EPA, Centers for Disease Control and Prevention, and NASA GSFC will strengthen this proposed work and broaden the NPP's applied science component. The proposed tasks will also be leveraged from PI and Co-Is existing projects that heavily use the MODIS and MISR aerosol products for air quality application.

Robert Wolfe/NASA GSFC
VIIRS Geometric Calibration and Validation for NPP Earth System and Climate Data Records

Geometric calibration and validation is essential in producing Earth System Data Records (ESDRs) and Climate Data Records (CDRs) over heterogeneous terrestrial surfaces using the Visible Infrared Imager Radiometer Suite (VIIRS) sensor. In particular, accurate operational geolocation (Earth-location) is necessary for generating temporally composited products needed to support accurate retrieval of biophysical and geophysical parameters on multi-day temporal scales, and to enable inter-comparisons of multi-day composites. This proposed work will address geometric calibration and validation of the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP) VIIRS in support of higher level ESDRs and CDRs.

Because of the heterogeneity of terrestrial surfaces, accurate geolocation is essential to the production of ESDRs and CDRs from VIIRS moderate resolution sensor data. The Earth Observing System Moderate Resolution Imaging Spectrometer (MODIS) science team has developed remote sensing algorithms for deriving global time-series data products of various geophysical parameters used by the Earth science community. MODIS has demonstrated that it is possible to operationally produce geolocation data to the sub-pixel accuracies needed to support accurate retrieval of terrestrial biophysical and geophysical parameter ESDRs and CDRs. As NASA moves from missions to measurements, accurate geolocation is also needed to enable the retrieval of a new generation of ESDRs and CDRs from the NPP VIIRS. One of the key underlying capabilities is the ability to accurately inter-compare data from VIIRS to the MODIS data record at the same Earth locations.

The MODIS sub-pixel accuracies are achieved in forward processing and further improved through multiple reprocessing activities. Recent improvements in the MODIS geolocation algorithm to enable the use of finer resolution 500 m global digital elevation model data will result in improved accuracy in rough terrain. This is expected to improve the quality of the Land products that are needed in or challenged by rough terrain (e.g. snow cover, albedo and land surface type). We are proposing to provide the new algorithm for VIIRS implementation and testing. Based on the expected improvements in the Land EDR quality we will then provide the algorithm along with documentation of the benefits to the EDRs for consideration for inclusion in operational system.

This proposal's Principle Investigator Robert Wolfe and Co-Investigators Masahiro Nishihama and Guoqing Lin have developed a detailed understanding of the VIIRS instrument geometric characteristics and ancillary data requirements, and have evaluated

the accuracy of the operational VIIRS geolocation algorithm. All three are also part of the NPP Instrument Calibration and Support Element. Beginning in 2004, we have participated in the NPP VIIRS ambient and Thermal Vacuum tests with the goal of assuring that the operational NPP and future NPOESS VIIRS geolocation has the accuracy required to produce ESDRs and CDRs. As members of the government independent instrument characterization and assessment team, we have played a key role in developing a better understanding of the ambient and the TVAC test sources and conditions, which are key to interpreting the measurements and results.

Currently, an automatic filtering technique is being developed that will enable nearly autonomous long-term trending of MODIS geolocation data. This proposal will continue the work in understanding the VIIRS sensor and its pre-flight characterization and in evaluation of automatic long-term trending techniques. The proposal work will extend this activity into the NPP VIIRS post-launch era, particularly in the areas of post-launch sensor geometric characterization, evaluation of the on-orbit geolocation algorithm performance, and evaluation of automated long-term trending of the VIIRS geolocation data.

Kai Yang/University of Maryland Baltimore County
Continuation of Long-Term Sulfur Dioxide EDR with the NPP Ozone Mapping and Profiler Suite Nadir Mapper

We propose to produce a high quality environmental data record (EDR) of atmospheric column SO_2 using the backscattered ultra-violet (BUV) radiance measurements from the NPP OMPS Nadir Mapper. This SO_2 EDR will serve these objectives:

1. to continue and improve the OMI public SO_2 data record of major anthropogenic and volcanic degassing SO_2 sources;
2. to extend the long-term explosive volcanic S_2 emission data record that started from TOMS in 1978 and continued to date with OMI;
3. to provide explosive volcanic SO_2 emission height estimates;
4. to evaluate the OMPS nadir total ozone EDR in the presence of SO_2 and aerosol, and to establish procedures to reduce ozone errors using the information in the SO_2 EDR;
5. to provide near-real-time volcanic SO_2 and ash detection for the application in aviation decision support.

Method/Results: OMPS, with its hyper-spectral nadir mapper covering the wavelength range of 300 - 380 nm in a single spectral band (as opposed to OMI's division of this spectral range into two bands at 310 nm), is uniquely suitable for improved SO_2 measurements. We will apply the recently developed extended iterative spectral fitting (EISF) algorithm to OMPS BUV measurements to retrieve SO_2, ozone, and aerosol index simultaneously. The height of the SO_2 plume will also be estimated for high SO_2 loading cases, such as those from explosive volcanic eruptions. Because of the single-band measurements with a high signal-to-noise ratio, OMPS's volcanic SO_2 product is expected to have a higher quality compared to those from the predecessor instruments, and hence will provide more reliable information to a broader modeling and analysis community for study of atmospheric chemistry, volcanology, and air quality.

Our proposal responds to NASA solicitation of NPP Science Team for Climate Data Records in accordance with the requested investigations to 1) develop and evaluate improvements to EDR algorithms that could make them more suitable as ESDRs or CDRs, because our retrievals provide the information (SO_2 amount and the improved aerosol index) needed to correct errors and biases in the NPP mission critical total ozone EDR; 2) develop scientific approaches for continuing key ESDRs begun by EOS, because SO_2 measurement is such a data record omitted from the initial plans for NPP/NPOESS; 3) develop and demonstrate innovative and practical applications, for which the proposed aviation decision support is qualified by providing near-real-time tracking of volcanic plumes.

Our group at GEST/UMBC and NASA/GSFC has created a long-term EDR of volcanic SO2 emissions (1978 - 2010). The EDR contributed from the OMI measurements is being reprocessed using the same EISF algorithm proposed here to ensure consistency of the entire EDR. The proposed research builds on the expertise of our proposal team in satellite remote sensing of atmospheric constituents including trace gases and aerosols, and their experiences in developing and maintaining the OMI operational and NRT SO2 data.